3. "Theory of the reciprocal Action between the Solar Rays and the different Media by which they are reflected, refracted or absorbed." By Joseph Power, Esq., M.A., Fellow of Clare Hall and Librarian of the University of Cambridge, &c. Communicated by the Rev. Jonathan Cape, M.A., F.R.S. Received May 26, 1853.

For the train of thought which suggested the considerations in this communication, the author states that he is more particularly indebted to the researches of Professor Draper of New York, contained in his work "On the Organization of Plants, the Chemical effects of the Solar Rays," &c., his experiments tending to show that the law of action and reaction which prevails so generally in other departments of nature is no less true in all the varied phenomena of the sun-beam, so that the latter cannot be reflected, refracted, much less absorbed, without producing some effect upon the recipient medium. Whilst however he acknowledges the information he has received from that work, he differs in opinion with its author, as to the necessity of admitting more than one imponderable, being strongly of opinion that all the effects of the solar rays may be attributed to some or other of the infinite variety of undulations of which the universal ether is capable, and which, in the case of the sun-beam, are impressed upon it at the surface of the sun. He considers that the *vis viva*, which has its origin in these vibrations, is transmitted through the ether, with the velocity of light, in extremely minute undulations of different lengths and periods. If then a sun-beam, fraught with a vast variety of such undulations, be incident upon a medium so constituted that particles are capable of vibrating in unison, or even in harmonious consonance less perfect than unison, with some or other of the ethereal vibrations of the incident beam, it must necessarily happen that one system of vibrations will be called into existence by the other according to the laws of *Resonance*. He states that there may be a difficulty in explaining, but there can be no doubt of the fact, that the *vis viva* due to such induced vibrations may, like those of heat, become more or less persistent in the medium, producing at one time the phenomenon of fixed chemical action; at another that of permanently latent heat; at another that of less permanently latent or retarded heat; at another that of coloration and absorption; at another that of phosphogenic action. The remarkable phenomena lately discovered by Professor Stokes seem to him to be closely allied to the latter, differing however in the circumstance that they cease to exist the moment the exciting rays are withdrawn. Guided by analogy, he is, however, inclined to think that these phenomena will be found hereafter to possess some slight though insensible duration, while he regards all action which is really momentary as expending itself upon the passing rays as they emerge in the form of reflected or refracted rays.

But all these effects, of whatever kind, the author regards as due to one and the same cause, which can be no other than the expenditure or distribution of the *vis viva* originally derived from the sun, and conveyed by the ether. Such expenditure he considers we may regard as of two kinds, according as the *vis viva* is retained by the

medium, or transmitted with the emergent rays. If it be expended solely upon the emergent rays, the *vis viva* of the incident ray ought to be exactly equal to the sum of the *vires vivæ* of the reflected and refracted rays. But if it be partly expended on the medium and partly upon the emergent rays, the *vis viva* of the incident ray ought to exceed the *vires vivæ* of the reflected and refracted rays by a certain quantity. The object of his present investigation was to take into account the effect of such supposed excess, in the hope of arriving at some explanation of the Stokesian phenomena. The remarkable result he has obtained, that *every loss of* vis viva *will be accompanied with a diminution of the refractive index*, is quite in the direction of Professor Stokes's own idea of "a change of refrangibility," but throws no light on the change of *period*. This the author is inclined to think is due to an action of the nature of harmonic resonance, and from some calculations which he has made, he thinks it probable that the light produced in the Stokesian experiments may be due to resonant vibrations which are about a major or minor third lower in pitch than those of the invisible rays producing them.

The mode of procedure which appeared to the author most likely to lead to a successful result, was to assume, in the first instance, the hypothesis that the *vis viva* is expended solely on the reflected and refracted rays, and afterwards to modify, if possible, the steps of the process so as to adapt them to the hypothesis that a portion of it is expended on the medium. In adopting the more simple hypothesis, he was much struck by the formulæ at which he arrived; for not only did the general law of refraction spring out most unexpectedly, but the very same expressions for the intensity of the reflected rays, which were first discovered by Fresnel, and subsequently verified by the experiments of Brewster and Arago, were an immediate consequence of the formulæ. His results however differ in some particulars from those of Fresnel. In the first place, the index of refraction is not the simple quotient of the velocities of undulation, but of those velocities each multiplied by the density of the ether in the corresponding medium. In the second place, the vibrations of the ethereal particles are performed *in* the plane of polarization, and *not perpendicular* to that plane, as Fresnel supposed. Further, the expressions for the intensities of the refracted rays differ slightly in other respects from those of Fresnel, as given in Airy's Tracts.

The author states that he confines his attention to an isotropical singly refracting medium, though he thinks, if he had more time at his disposal, he could extend the theory to doubly refracting crystals. A very simple integration gives him a general expression for the *vis viva* of an elementary cycloidal wave, in terms of the amplitude and the constants of the periodical function. By help of this he obtains two equations of *vis viva*; one for a wave whose vibrations are in the planes of incidence, and the other for a wave whose vibrations are perpendicular to that plane, both vibrations being transverse to the axis of the ray. By the principle of superposition these two equations will hold true simultaneously when the above waves are

regarded as the components of one and the same wave. He obtains three other equations between the amplitudes from the simple consideration that a particle situated in the common surface of the two media cannot vibrate in more than one way at once. Of these three equations two involve the amplitudes of the first component wave, and the third those of the second. The five equations serve to determine, in terms of the angle of incidence and the component amplitudes of the incident wave, the five following quantities, namely, the angle of refraction, the two component amplitudes of the reflected wave, and those of the refracted wave.

By the aid of the result referred to, that every loss of *vis viva* is always accompanied by a diminution of the refractive index, coupled with the general view which he takes of the cause of absorption, the author is enabled to give an explanation of Frauenhofer's lines, and in general of the lines of absorption in coloured media; and also to explain the phenomena discovered by Sir David Brewster, that violet light may exist in the blue spaces, and blue light in the red.

In the course of the investigation, the altered expressions for the intensities of the reflected and refracted rays, so far as they are affected by the coefficient of absorption, are given. The expressions for the intensities of the two component reflected waves are very little affected; but those for the intensities of the two component refracted waves are materially altered in value.

The theory likewise affords an explanation, the first the author believes that has ever been offered, of the remarkable properties of saccharine solutions and of certain crystals, such as right-handed and left-handed quartz, which exhibit the phenomenon of circular polarization.

June 16, 1853.

The EARL OF ROSSE, President, in the Chair.

The following gentlemen were admitted into the Society:—

Joseph Prestwich, Esq.; William Wilson Saunders, Esq.; and William Spottiswoode, Esq.

The following papers were read:—

1. "On the Anatomy and Physiology of *Cordylophora*, a contribution to our knowledge of the Tubularian Zoophytes." By George James Allman, M.D., M.R.I.A., Professor of Botany in the University of Dublin, &c. Communicated by Professor Edward Forbes, F.R.S. &c. Received May 31, 1853.

The author, after pointing out the necessity of giving greater definiteness to the terminology employed in the description of the true zoophytes, proceeds to the anatomical details of *Cordylophora*, a genus of *Tubulariadæ*. He demonstrates that *Cordylophora* is essentially composed in all its parts of two distinct membranes enclosing a cavity, a structure which is common to all the *Hydroida*. For greater precision in description, he finds it necessary to give to these